PBEEEP
State Government

Public Buildings Enhanced Energy Efficiency Program

SCREENING RESULTS FOR ORVILLE FREEMAN BUILDING

Admin Minnesota
DEPARTMENT OF ADMINISTRATION

January 28, 2011

Summary Table

Orville Freeman Building	
Location	625 Robert Street North Saint Paul, MN 55155
Facility Manager	Gene Peterman
Number of Buildings	1
Interior Square Footage	374,744
PBEEEP Provider	Center for Energy and Environment (Neal Ray)
State's Project Manager	Pat Ferrin
Date Visited	January 12, 2011
Annual Energy Cost (from B3)	$506,872 (2009)
Utility Company	District Energy St. Paul (Hot and Chilled Water), Xcel Energy (Natural Gas and Electricity)
Site Energy Use Index (from B3)	72.2 kBtu/sq ft(2009)
Benchmark EUI (from B3)	104.7 kBtu/sq ft

Screening Overview

The goal of screening is to select buildings where an in-depth energy investigation can be performed to identify energy savings opportunities that will generate savings with a relatively short (1 to 5 years) and certain payback. The screening of Orville Freeman Building was performed by the Center for Energy and Environment (CEE) with the assistance of the facility staff. A walk-through was conducted on January12, 2011 and interviews with the facility staff were carried out to fully explore the status of the energy consuming equipment and their potential for recommissioning. This report is the result of that information.

The Orville Freeman Building is a 374,744 square foot (sqft) building located in St. Paul, MN. The building consists of primarily office space

Recommendation for Investigation

Due to Orville Freeman Building's low energy use, scheduling of mechanical equipment, and operation of mechanical equipment CEE does not recommend any further investigation.

Building Name	State ID	Square Footage	Year Built
Orville Freeman Building	G02310272	374,744	2005

Building Overview Section

Mechanical Equipment

The building is conditioned by hot and chilled water from St. Paul District Energy. The hot water is available year-round and the chilled water is available from April 1st to November 1st each year. District hot water is brought into the basement of the building where it is then run through five water to water heat exchangers. The water is circulated through the building by three hot water pumps. The district chilled water is also brought into the basement, but there are no heat exchangers in the chilled water loop. The district chilled water is pumped directly to the air handlers to provide cooling by three chilled water pumps.

There are 9 large AHUs which supply air to the office spaces within the buildings. These units contain both supply and return fans with VFDs. There are a total of 265 VAV boxes with reheat coils and 37 fan powered VAV boxes associated with these AHUs. These units contain a steam humidifier, chilled water coil, and hot water coil.

There are four other constant volume AHUs with reheat coils which serves elevator, mechanical, and electrical rooms.

AHU-3, 4, 5, 6, 7, 9, and 10 are ducted in a way where they share a common supply duct and distribute air to the same areas. Due to this, facility staff has determined space conditions can be satisfied without running AHU-3 and AHU-10 so those units no longer run.

Controls and Trending

The building runs on a Honeywell EBI R310.1 Building Automation System (BAS), which is part of the State Capitol Complex system. The Plant Management Division (PMD) of the Department of Administration controls the BAS.

Lighting

Indoor lighting- Interior lighting primarily consists of T8 32 watt lights. These lights are controlled by a Lutron ® lighting system. The lights are on a schedule and are off when occupants are not in the space. There are also occupancy sensors for offices which will shut the lights off if there are no occupants in the space. There are CFL lights in the hallways. Mechanical rooms and areas uses by building facility staff are controlled by light switches.

Outdoor lighting- The outdoor lighting consists of high pressure sodium (HPS) and metal halide lighting. The outside lighting which is more decorative consists of metal halide. These lights are also on the Lutron system and are controlled by a photocell and timer.

There was a lighting study done to this building in February 2010. The main recommendations which came from it were to change the scheduling of the lights with respect to daylight in the space, tie the Lutron lighting system into the Honeywell EBI system, and change some of the current T8 32 watt lights to super energy saver T8 25 watt lights.

Energy Use Index B3 Benchmark

The site Energy Use Index (EUI) for the building is 72 kBtu/sqft, which is 31% lower than the B3 Benchmark of 105 kBtu/sqft. The site EUIs for State of Minnesota buildings are 23% lower than their corresponding B3 Benchmarks on average. This shows the Orville Freeman Building is performing better than average state buildings in Minnesota.

Metering

The building contains two electrical meters, one hot water meter for district hot water, one chilled water meter for district chilled water, and one natural gas meter.

Documentation

The building contains as built prints dated May 12, 2004. There are also control submittals for mechanical equipment, mechanical submittals for all mechanical equipment, and operation and maintenance manuals for all equipment. Testing and balancing was started on the building, but never completed due to conflicts with maintenance staff. There are no balance reports due to this.

Occupancy

The building is primarily five floors of office space; most employees usually are in the building from 8 AM to 5 PM Monday through Friday. There are people arriving as early as 6 AM and others who leave as late as 6 PM.

Additional Information from Occupant Interviews and Observations

The following information is **unverified** and was obtained through occupant interviews and/or general observations by the PBEEEP Screening team. This information is provided for reference only:

- There was an energy study recently done last year on the complex by Herzog Wheeler Associates which had limited energy saving findings in it.
- The AHUs minimum outside air dampers do not work properly so they are not used
- Due to the set up of the duct work and how units serve the space facility staff currently does not run AHU-3 or 10 to save energy.
- The system was designed to utilize reheats in the VAV during the summer to control humidity levels; however the building does not receive HW from district energy during the summer so reheats are not used.
- There are three hot water pumps in the building distributing hot water. Two pumps are used and one is a backup and they are rotated. During site visits one pump was running at 85% and the other one was at 19%.
- The testing and balancing of the mechanical equipment was never completed
- The two steam generators and 5 hot water heaters are not on the building automation system.

Mechanical Equipment Summary Table	
Quantity	**Equipment Description**
1	Honeywell EBI Automation System
1	Building
374,744	Interior Square Feet (before 1,200 sqft addition)
13	Air Handlers
265	VAV Boxes (113 with reheats and 154 without)
37	Fan powered VAV boxes
3	FCUs
5	Water to Water Heat Exchangers
3	Hot Water Pumps
3	Chilled Water Pumps
3	Dry Coolers
2	Pumps associated with glycol and CRAC units
4	CRAC Units
10	Hot water pumps for AHU coils
6	CUHs
6	HUHs
4	VUHs
2	Power Roof Ventilators
7	Exhaust Fans
630	Approximate number of points for trending

Important Note

The Health Agriculture Laboratory and Orville Freeman Office building in the state capitol complex are connected together by a skyway on the third floor. The buildings do not share the same mechanical equipment and the skyway contains doors to each building and there is limited interaction between the two buildings.

This screening report is based on the PBEEEP Guidelines. It is based on one site visit, review of the facility documentation, building automation system, a limited inspection of the facility and interviews with the staff. The purpose of the screening report is to evaluate the potential of the facility for the implementation of cost-effective energy efficiency savings through recommissioning. To the best of our knowledge the information here is accurate. It provides a high level view of many of the important parameters of the mechanical equipment in the facility. Because it is the result of a limited audit survey of the facility, it may not be completely accurate or inclusive.

Additional comments from site visit

The Freeman building appears to be a lower energy using building and during the screening process not much potential for energy savings was observed. There were three areas that facility *could* look into to possible save more energy. One area where facility staff could experiment with is with AHU-3 and AHU-10. Due to how the system distributes air to the building, staff at one point decided to turn off AHU-3 and AHU-10 because they serve the same area as AHU-4 and AHU-9. All four of these AHUs contain 75 HP supply fan motors. It was determined only two AHUs were needed to serve these spaces versus four. During the site visit AHU-4 and 9 were running at 61%. This equates to approximately 28 HP each, a total of 56 HP for both AHUs. Because the power consumption of a motor is decreased by a factor of 2 to 3 times as fan speed is decreased (depending on the fan curve), greater energy savings could be achieved by operating all four motors simultaneously at lower (balanced) speeds. For this instance if all the fans were on and the units all had a fan speed of 40% versus two fans with a speed of 61% the total HP of the 4 fans would be 48 HP, which is 8 HP less than the current set up (this does not include return fan HP reduction possible as well). This is due to the relationship of fan laws. This is something facility staff could experiment with.

The second area noticed which should be addressed is the operation of the hot water pumps. During the site visit it was observed two of the three hot water pumps were on. One was running at 85% speed and the other was running at 19% speed. First it should be noted the pump more than likely is not moving water through the system at only 19% speed. Depending upon the pump curve and the system, the pumps typically need to be running at 30% to distribute water in the system. When pumps run at a slower speed cavitation could also become an issue which could damage the pump. In this type of system when multiple pumps feed the same water loop, both pumps should be running at the same speed. There is also an energy benefit for the same reason as above: when the speed of the motor is reduced the power consumption of the pump is typically reduced by a factor of 2 to 3 times depending upon the pump curve. The sequence of operations should include instructions such as: once one pump runs at 75% both pumps engage and modulate their speed in unison to maintain either demand in the space or differential pressure setpoint. Once the speed of both pumps drops below 35% only one pump should then run.

The last area which should be addressed is the fact the building has never had testing and balancing completed. When the original testing and balancing was being performed, there were issues between the balancing contractor and facility staff and it was never completed. It is probable that the system performance would improve if it were balanced properly.

Building Summary Table

The following tables are based on information gathered from interviews with facility staff, a building walk-through, automation system screen-captures, and equipment documentation. The purpose of the tables is to provide the size and quantity of equipment and the level of control present in each building. It is complete and accurate to the best of our knowledge.

Freeman Office State ID# G02310272					
Area (sqft)	374,744	Year Built	2005	EUI/Benchmark	72.2/104.7
HVAC Equipment					

Air Handlers (13 Total)

Description	Type	Size	Notes
AHU 1	Constant volume	12,000 CFM 15 HP SF	Contains a gas to steam humidifier, hot water coil, 2 chilled water coils, and 2 reheat coils for two zones
AHU 2	Variable air volume	27,500 CFM 50 HP SF 15 HP RF	Contains a gas to steam humidifier, hot water coil, 2 chilled water coils, and VAV boxes
AHU 3	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 2 chilled water coils, and VAV boxes
AHU 4	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 3 chilled water coils, and VAV boxes
AHU-5	Variable air volume	27,500 CFM 50 HP SF 15 HP RF	Contains a gas to steam humidifier, hot water coil, 2 chilled water coils, and VAV boxes
AHU-6	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 3 chilled water coils, and VAV boxes
AHU-7	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 3 chilled water coils, and VAV boxes
AHU-8	Variable air volume	27,500 CFM 50 HP SF 15 HP RF	Contains a gas to steam humidifier, hot water coil, 2 chilled water coils, and VAV boxes
AHU-9	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 3 chilled water coils, and VAV boxes
AHU-10	Variable air volume	44,000 CFM 75 HP SF 20 HP RF	Contains a gas to steam humidifier, hot water coil, 3 chilled water coils, and VAV boxes
AHU-11	Constant volume	6,000 CFM 5 HP SF	2 reheat zones
AHU-12	Constant volume	6,000 CFM 5 HP SF	3 reheat zones
AHU-13	Constant volume	6,000 CFM 5 HP SF	2 reheat zones

HVAC Equipment Cont'd

VAV Boxes (265 Total)

Description	Type	Size	Notes
VAV boxes	Reheat	125-3,420 CFM	

Fan Coil Units (3 Total)

Description	Type	Size	Notes
FCU-1	Magicaire	5,000 CFM 3 HP	
FCU-2	Magicaire	4,000 CFM 1.5 HP	
FCU-3	Magicaire	3,000 CFM 1 HP	

Fan Powered VAV Boxes (37 Total)

Description	Type	Size	Notes
VAV boxes	Series and Parallel	340 to 2,100 Primary CFM	10 Parallel 27 Series

Chilled Water System

Description	Type	Size	Notes
P-1 P-2 P-3	Variable Volume CHWPs	25 HP 800 gpm	3 CHWPs circulate district chilled water all three pumps contain VFDs

Hot Water System

Description	Type	Size	Notes
WHE-1	HW to HW Heat Exchanger	250 gpm	Heat exchanger for between District HW and building HW
WHE-2	HW to HW Heat Exchanger	250 gpm	Heat exchanger for between District HW and building HW
WHE-3	HW to HW Heat Exchanger	250 gpm	Heat exchanger for between District HW and building HW
WHE-4	HW to HW Heat Exchanger	250 gpm	Heat exchanger for between District HW and building HW
WHE-5	HW to HW Heat Exchanger	250 gpm	Heat exchanger for between District HW and building HW
P 4 P 5 P 6	Variable volume HWPs	15 HP 500 gpm	Pumps run two at a time with one as back up. All three pumps contain VFDs

HVAC Equipment Cont'd

CUH (6 total)

Description	Type	Size	Notes
CUH 1 through CUH-6	Hot water	25.5 to 48.0 kBtu/hr	

VUH (4 total)

Description	Type	Size	Notes
VUH 1 through 4	Hot water	61 kBtu/hr	

HUH (6 total)

Description	Type	Size	Notes
HUH 1 through HUH-6	Hot water	45 to 82 kBtu/hr	

Glycol and CRAC Room AC Units System

Description	Type	Size	Notes
DC-1	Liebert	310.5 kBtu/hr	
DC-2	Liebert	310.5 kBtu/hr	
DC-3	Liebert	310.5 kBtu/hr	
Pump-7	Constant Volume	5 HP 120 gpm	Works with glycol and CRAC units
Pump-8	Constant Volume	5 HP 120 gpm	Works with glycol and CRAC units
MCU-1	Liebert	108.3 kBut/hr t	Size is total cooling capacity
MCU-2	Liebert	108.3 kBut/hr t	Size is total cooling capacity
MCU-3	Liebert	108.3 kBut/hr t	Size is total cooling capacity
MCU-4	Liebert	108.3 kBut/hr t	Size is total cooling capacity

Power Roof Ventilators (2 total)

Description	Type	Size	Notes
PRV-1	Constant volume	3,000 CFM 0.33 HP	
PRV-2	Constant volume	3,000 CFM 0.33 HP	

HVAC Equipment Cont'd

Exhaust Fans (7 Total)

Description	Type	Size	Notes
EF-1	Variable volume	3,200 CFM 0.5 HP	Contains VFD which never modulates
EF-2	Variable volume	5,500 CFM 3 HP	Contains VFD which never modulates
EF-3	Variable volume	3,675 CFM 2 HP	Contains VFD which never modulates
EF-4	Variable volume	4,600 CFM 2 HP	Contains VFD which never modulates
EF-5	Variable volume	1,900 CFM 1 HP	Contains VFD which never modulates
EF-6	Variable volume	5,620 CFM 3 HP	Contains VFD which never modulates
EF-7	Variable volume	4,570 CFM 2 HP	Contains VFD which never modulates

Hot Water Coil Pumps (10 Total)

Description	Type	Size	Notes
P-9	Constant Volume	0.25 HP	For HW coil on AHU-1
P-10	Constant Volume	0.5 HP	For HW coil on AHU-2
P-11	Constant Volume	0.5 HP	For HW coil on AHU-3
P-12	Constant Volume	0.5 HP	For HW coil on AHU-4
P-13	Constant Volume	0.5 HP	For HW coil on AHU-5
P-14	Constant Volume	0.5 HP	For HW coil on AHU-6
P-15	Constant Volume	0.5 HP	For HW coil on AHU-7
P-16	Constant Volume	0.5 HP	For HW coil on AHU-8
P-17	Constant Volume	0.5 HP	For HW coil on AHU-9
P-18	Constant Volume	0.5 HP	For HW coil on AHU-10

Points on BAS

Air Handlers

Description	Points
AHU-1	AHU command, OA damper %, MAT, MAT setpoint, HW coil pump command, HW coil pump status, HW coil valve %, CHW valve %, Humidifier valve %, SA CFM, SF command, SF status, DAT, DAT setpoint, DA RH, DA RH setpoint, Reheat valve %, Space temperature, Space temperature setpoint, RARH, OAT, OA humidity
AHU-2 AHU-3 AHU-4 AHU-5 AHU-6 AHU-7 AHU-8 AHU-9 AHU-10	AHU command, Occupied command, OAT, OARH, OA enthalpy, OA damper %, Minimum OA damper %, MA duct static pressure, MA duct static pressure setpoint, MAT1, MAT2, MAT setpoint, Face bypass damper %, HW coil pump command, HW coil pump status, HW coil valve %, CHW valve %, Humidifier valve %, SA CFM, SF command, SF status, SF speed, DAT, DAT setpoint, DA RH, DA RH setpoint, Duct static pressure, Duct static pressure setpoint, RA CFM, RF command, RF status, RF speed, EA damper %, RAT, RARH, RARH setpoint, Return duct static pressure, Return duct static setpoint, RA CO_2
AHU-11 AHU-12 AHU-13	AHU command, Occupied command, OAT, OA humidity, OA damper %, CHW valve %, SF status, MAT, MAT setpoint, Reheat valve %, Space temperature, Space temperature setpoint, Highest room temperature

VAV Boxes

Description	Points
Each Unit	Max CFM, Actual CFM, Min CFM, Damper position, HW reheat valve, Room temperature, Room temperature setpoint

Chilled Water System

Description	Points
System	System command, Pump status, Pump speed, Differential pressure 1, Differential pressure 2, Differential pressure setpoint, CHW valve % from district, CHWST, CHWRT, OAT, OA enable setpoint

Exhaust Fans with VFDs

Description	Points
EF-1 EF-2 EF-3 EF-4 EF-5 EF-6 EF-7	Fan status, Fan speed, Damper command

Points on BAS Cont'd

Fan Coil Units

Description	Points
FCU-1 FCU-2 FCU-3	Space temperature, Space temperature setpoint, Heating valve %, Cooling valve %, Fan status

Hot Water System

Description	Points
System	System enable, District HWST, District HWRT, Heat exchanger valve %, Pump status, Pump speed, Differential pressure 1, Differential pressure 2, Differential pressure setpoint, OAT pump enable, HWST, HWRT, High limit HWST, Low limit HWST, OAT

CUH

Description	Points
CUH-1 through CUH-6	Space temperature setpoint, Space temperature, Valve %

VUH

Description	Points
VUH-1 through VUH-4	Space temperature setpoint, Space temperature, Valve %

HUH

Description	Points
HUH-1 through HUH-6	Space temperature setpoint, Space temperature, HUH enable

Glycol and CRAC Units

Description	Points
System	Dry cooler status, Dry cooler valve command, Dry cooler supply temperature, Pump status, Pump valve %, CRAC unit supply temperature, Space temperature, Space temperature setpoint

PRV

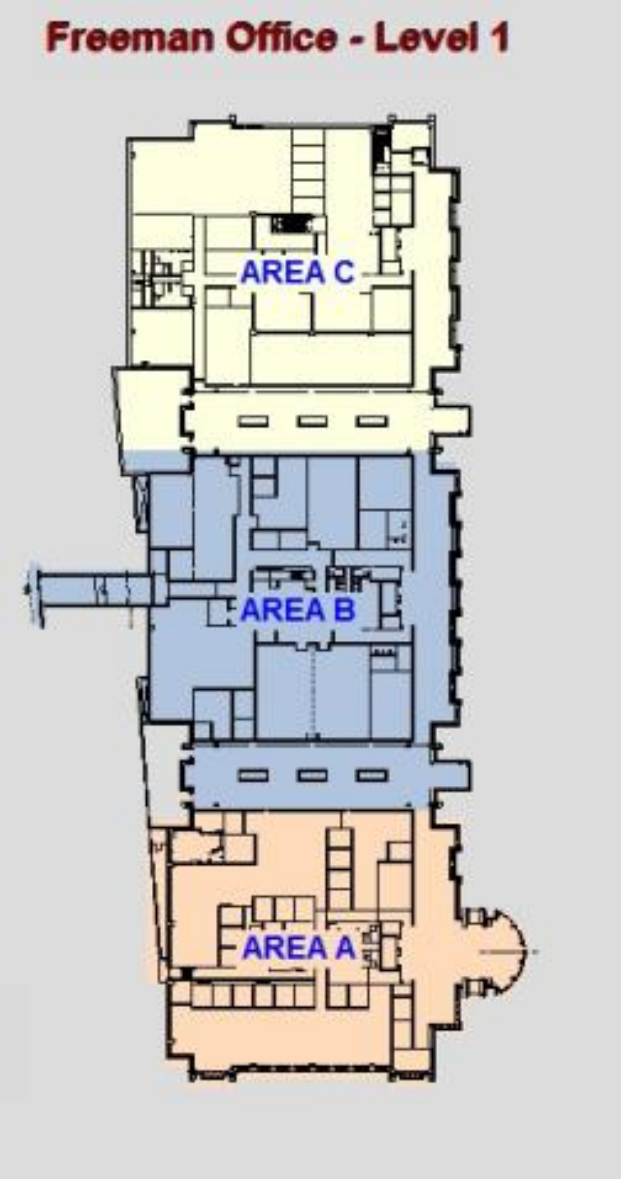
Description	Points
PRV-1 PRV-2	Fan command, Fan status

Generator Room Temperature Control

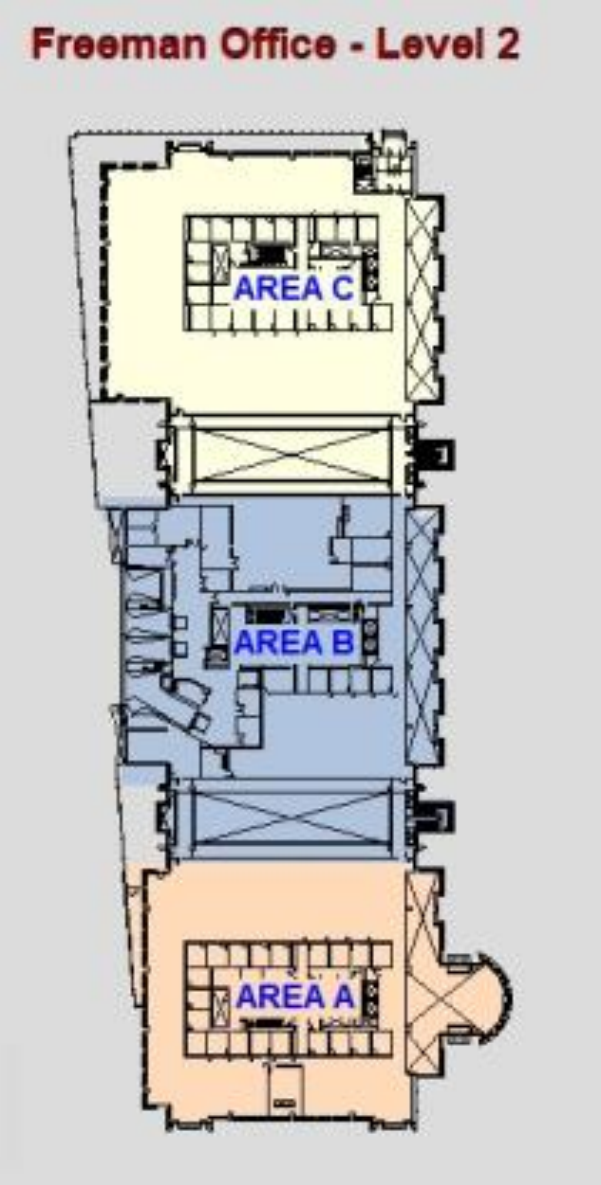
Description	Points
System	RA damper %, EA damper %, OA damper %, Unit heater status, Room temperature, Room temperature setpoint,

Building Floor Plans

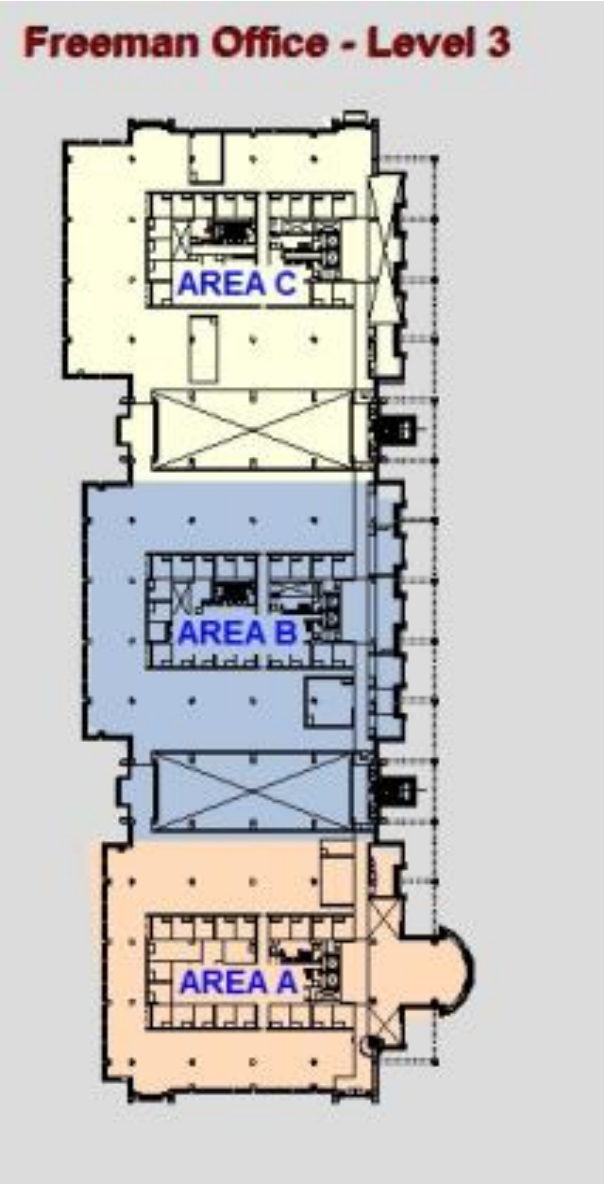
First Floor



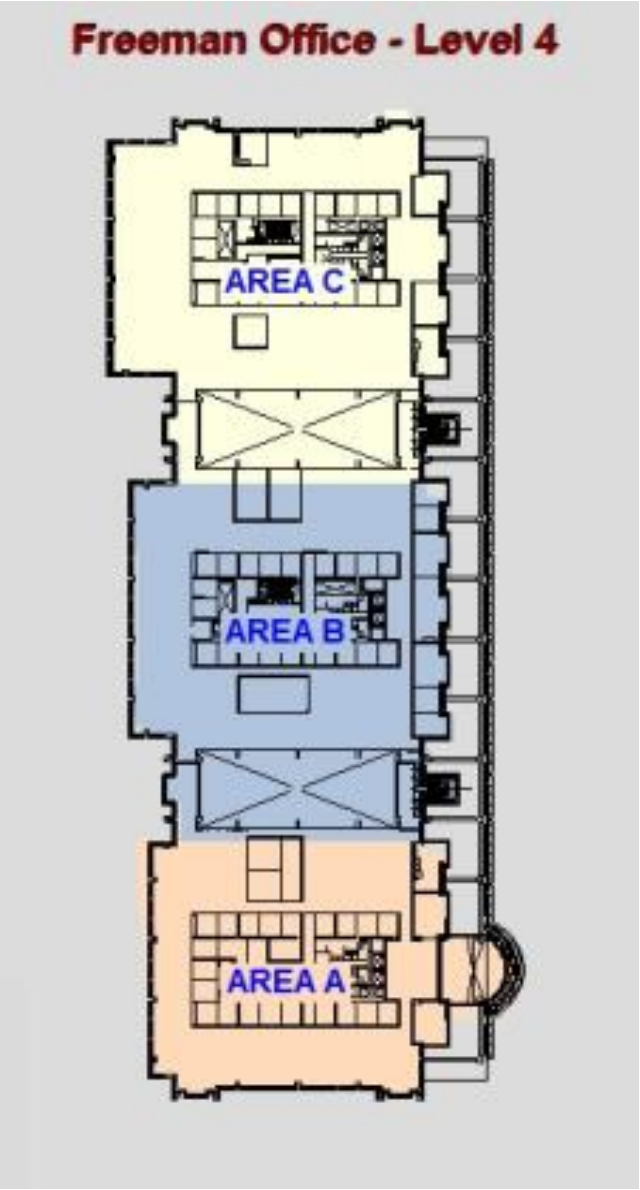
Second Floor



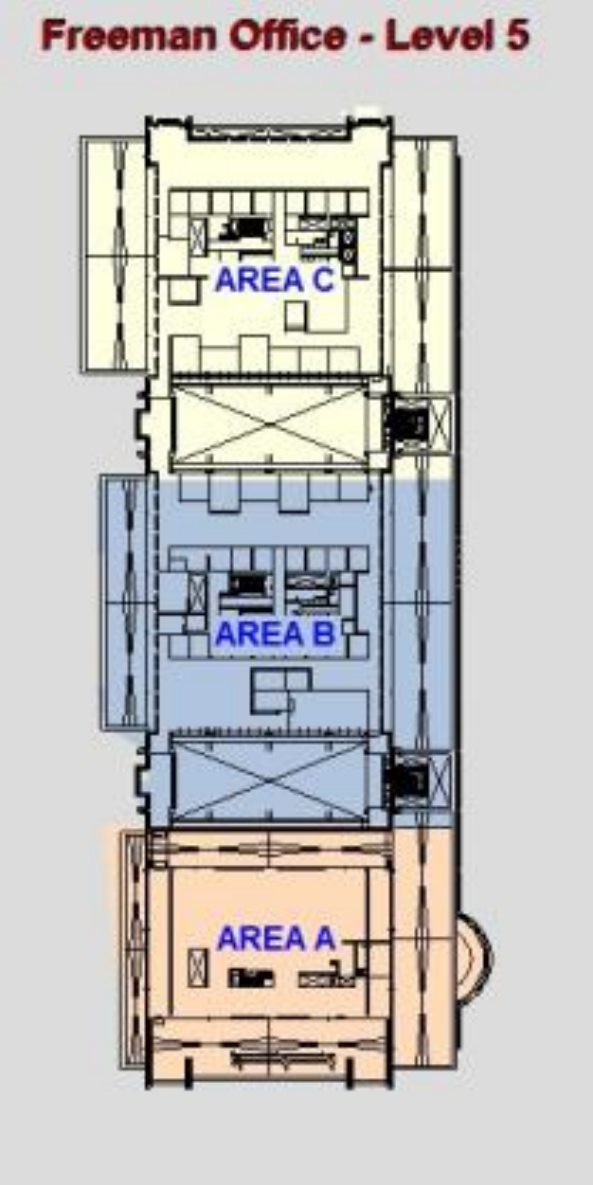
Third Floor



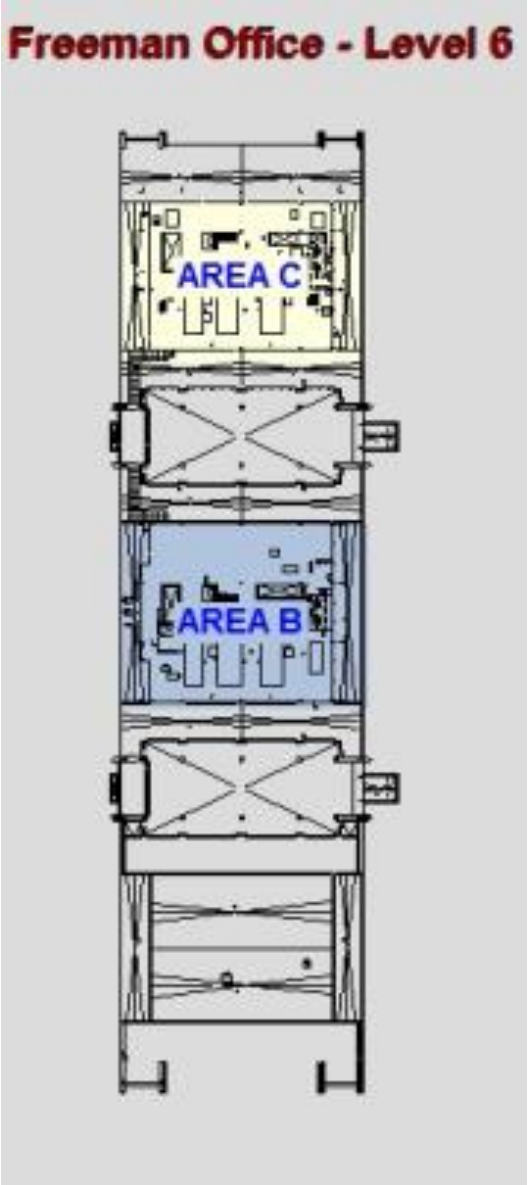
Fourth Floor



Fifth Floor



Sixth Floor



PBEEEP Abbreviation Descriptions			
AHU	Air Handling Unit	HUH	Horizontal Unit Heater
BAS	Building Automation System	HRU	Heat Recovery Unit
CD	Cold Deck	HW	Hot Water
CDW	Condenser Water	HWDP	Hot Water Differential Pressure
CDWRT	Condenser Water Return Temperature	HWP	Hot Water Pump
CDWST	Condenser Water Supply Temp	HWRT	Hot Water Return Temperature
CFM	Cubic Feet per Minute	HWST	Hot Water Supply Temperature
CHW	Chilled Water	HX	Heat Exchanger
CHWRT	Chilled Water Return Temperature	kW	Kilowatt
CHWDP	Chilled Water Differential Pressure	kWh	Kilowatt-hour
CHWP	Chilled Water Pump	MA	Mixed Air
CHWST	Chilled Water Supply Temperature	MA Enth	Mixed Air Enthalpy
CRAC	Computer Room Air Conditioner	MARH	Mixed Air Relative Humidity
CUH	Cabinet Unit Heater	MAT	Mixed Air Temperature
CV	Constant Volume	MAU	Make-up Air Unit
DA	Discharge Air	OA	Outside Air
DA Enth	Discharge Air Enthalpy	OA Enth	Outside Air Enthalpy
DARH	Discharge Air Relative Humidity	OARH	Outside Air Relative Humidity
DAT	Discharge Air Temperature	OAT	Outside Air Temperature
DDC	Direct Digital Control	Occ	Occupied
DP	Differential Pressure	PTAC	Packaged Terminal Air Conditioner
DSP	Duct Static Pressure	RA	Return Air
DX	Direct Expansion	RA Enth	Return Air Enthalpy
EA	Exhaust Air	RARH	Return Air Relative Humidity
EAT	Exhaust Air Temperature	RAT	Return Air Temperature
Econ	Economizer	RF	Return Fan
EF	Exhaust Fan	RH	Relative Humidity
Enth	Enthalpy	RTU	Rooftop Unit
ERU	Energy Recovery Unit	SF	Supply Fan
FCU	Fan Coil Unit	Unocc	Unoccupied
FPVAV	Fan Powered VAV	UH	Unit Heater
FTR	Fin Tube Radiation	VAV	Variable Air Volume
GPM	Gallons per Minute	VFD	Variable Frequency Drive
HD	Hot Deck	VIGV	Variable Inlet Guide Vanes
HP	Horsepower	VUH	Vertical Unit Heater

Conversions:
1 kWh = 3.412 kBtu
1 Therm = 100 kBtu
1 kBtu/hr = 1 MBH